# OTC 18332

# The Development of a Recommended Practice for Structural Integrity Management (SIM) of Fixed Offshore Platforms

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## Abstract

This paper summarizes the proposed API Recommended Practice for Structural Integrity Management (RP 2SIM) for fixed offshore platforms. The proposed RP has been under development for the past two years and pending API approval, should be published within the next year. The new RP will serve as a companion to API RP 2A, which will be restructured to focus solely on the engineering of new platforms, with the new document focused on the integrity management of existing platforms.

RP 2SIM will contain updated versions of the above and below water Structural Survey (Section 14) and Platform Assessment (Section 17) from the present RP 2A. The document will also contain guidance on data collection, risk-based inspection (RBI), assessment methods, assessment criteria, damage assessment, upgrades and repairs, and platform decommissioning. It is being written in a manner to make it consistent with similar ISO guidance on SIM, and will provide considerably more in-depth guidance for maintaining existing platforms than is presently available in RP 2A. RP 2SIM will be a timely addition to the API family of RPs for offshore platforms.

## Background

The design process has matured since platforms were first installed in the late 1940's. Figure 1 shows the evolution of offshore platform design in the Gulf of Mexico that has been based upon a combination of events such as hurricanes, development of standards such as API, and advances in industry practices. The first edition of API RP 2A used for designing fixed offshore platforms was published in 1969. Platforms built prior to this were designed to a wide variety of criteria and fabrication techniques; typically dependent upon the operator or the engineering/fabrication contractor. During the 1970's better application of design practices ensured higher engineering standards, until the first modern platforms began to be installed in the late 1970's using a consistent design recipe then available in RP 2A. Platforms installed since the early 1980's provide a more robust design and incorporate many of the lessons learned during the design, installation and operation of earlier platforms.

During the early 1990's an API task group developed RP 2A Section 17 for the Assessment of Existing Platforms. The guidance provided a process for evaluating older, existing, platforms to ensure that they were fit-for-purpose, including the use of metocean criteria that was lower than that for design of new platforms. Eventually adopted by API RP 2A in 1996, Section 17 has provided a process by which engineers can ensure fitness-for-purpose of existing offshore structures.

In the mid-1990's the International Standardization Organization (ISO) developed draft guideline 19902 for Fixed Steel Platforms, which contains recommendations for Structural Integrity Management (SIM). Some of the ISO SIM is similar to RP 2A Section 17, although the metocean acceptance criteria are specific for different worldwide regions as defined in Regional Annexes. The ISO SIM recommendations have enhanced the Section 17 principles and made the SIM process self contained; including *Data* gathering, *Evaluation* of the data, development of a *SIM Strategy* and the implementation of a *SIM Program*.

To ensure application of the API Section 17 recommendations in the Gulf of Mexico, the Mineral Management Service (MMS) issued Notice to Leases (NTL) No. 2003-G16. The NTL requires operators of over 3500 platforms to understand the API consequence category for each of their platforms and screen the platforms to determine if any required a fitness-for-purpose assessment. The MMS NTL is a multi- part approach extending to November 2006, which is the final date for the implementation of the assessments and any possible mitigation requirements.

About this same time, API was considering updates to Section 17 since it had been in use almost 10 years and some improvements and clarifications were necessary. A two-part process was implemented. The first part was to issue a "Supplement" to API RP 2A, which provides important updating to Section 17. Published by API in October 2005 [API, 2005] some of the key issues addressed by the Supplement include [O'Connor, et.al, 2005]:

- Revise the nomenclature of the assessment categories to A-1, A-2 and A-3 to avoid confusion with other sections of RP 2A.

- Add the A-2 medium consequence category (only high and low were contained in the original Section 17).
- Add wording on the "risk" of using the metocean criteria of Section 17 that provides for life and environmental safety, however the use may leave the platform subject to damage or collapse in extreme storms.
- Add a "Change-of Use" option, whereby the platform is used for a purpose other than its original intent (essentially an API Section 15 Reuse, but the platform remains in-place).
- Other technical clarifications as necessary, including improved commentary.

The second part was to develop a new RP, tentatively called RP 2SIM that covers the management of existing platforms. This development involves taking parts of RP 2A, including Section 14 on Surveys and Section 17 on Assessment, as well as, new guidance related to damage mitigation, and decommissioning, to create a stand-alone RP. Upon completion and adoption by API, RP 2A will be used for the design of new platforms and RP 2SIM will be used for integrity management of existing platforms. The two RPs will contain a number of cross-references, for example, the use of the RP 2A metocean loading "recipe" to compute metocean loads on existing platforms.

Over the past few years, there have been more fitness-for-purpose assessments of existing platforms than there have been new platform designs in the Gulf of Mexico. Recent damage to the Gulf of Mexico infrastructure from hurricanes Lili, Ivan, Katrina, and Rita makes it clear that SIM, including inspections and repairs following such events, is a very important part of the platform life-cycle. A more complete API document covering these issues is a therefore very timely.

The remainder of this paper reviews the current status of RP 2SIM, including an outline of each of the main sections and some of its basic concepts. A companion 2006 OTC paper by Westlake, et. al., [2006] discusses in detail several new concepts introduced by RP 2SIM related to the use of ultimate strength assessment for risk-based inspection and acceptance criteria.

## SIM Process

SIM is a process for ensuring the fitness-for-purpose of an offshore structure from installation through decommissioning. Specifically, SIM is a rational means for managing the effects of degradation, damage, changes in loading, accidental overloading, changes in use, and the experience gained during the evolution of the offshore design practice. SIM provides a framework for the inspection planning, maintenance, and repair of a platform or group of platforms.

The process contained in the RP 2SIM is illustrated in Figure 2 and consists of four primary elements: Data, Evaluation, Strategy and Program. The process is continuous and sequential and provides a logical framework for SIM. The approach is based upon an engineering evaluation of information arising from: the original design of the structure, inspection findings throughout its life, damage, overloading, and changes in loading and/or use. The RP 2SIM process is generally consistent with the ISO SIM process.

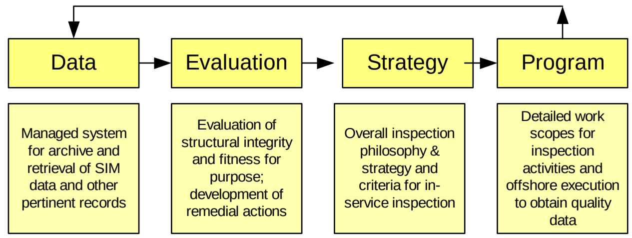


**Figure 2 – Primary Elements of the SIM Process**

## Document Outline

RP 2SIM has been organized around the framework of the SIM process shown in Figure 2, with the main sections of the document as follows:

- Section 1: Introduction, Purpose and Scope
- Section 2: Definitions and Acronyms
- Section 3: Structural Integrity Management Process
- Section 4: In-Service Inspection
- Section 5: Damage Evaluation
- Section 6: Structural Assessment Process
- Section 7: Assessment Criteria
- Section 8: Mitigation and/or Risk Reduction
- Section 9: Decommissioning

Sections 1 and 2 are general sections, typical of new API documents. In contrast, RP 2A uses Section 1 for background and definitions for many items used later in the document, for example definition of platform consequence categories. That is not the case for RP 2SIM, which follows the newer API document standards with a brief introduction followed by Section 2 containing all of the definitions, acronyms and references for the document.

The first section with significant content is Section 3, which describes the overall SIM approach and how to use the document. RP 2SIM will also be presented in the new API single column text format, as opposed to the double column format of RP 2A.

## Section 3: Structural Integrity Management Process

This section is the principal section describing the SIM process and provides the roadmap for using the RP. It contains a summary of each of the SIM processes and guidance to the engineer on the appropriate section within RP 2SIM required to perform the relevant SIM task. To assistant the engineer a flowchart, shown in Figure 3, is provided, which shows the key SIM processes and appropriate sections. The intent is that the engineer need only apply the portions of RP 2SIM necessary for the activity of concern. In this respect the document is written such that the sections are self-contained for the associated activity. For example, all platforms will require some sort of inspection and the engineer need only refer to Sections 3 and 4 for guidance. There is no need to refer to Section 6 related to Assessment or Section 8 related to Mitigation.

As shown in Figure 1, the key elements of Section 3 are Data, Evaluation, Strategy and Program. The challenge was to fit these elements within the existing RP 2A framework of

Sections 14 and 17 as well as the general approaches currently used by most operators for SIM. Each is described in the following subsections.

**Data**

An essential aspect of the SIM process is up-to-date platform information. Information on the original design/assessment, fabrication and installation, including results of numerical analyses, in-service inspections, engineering evaluations, structural assessments, modifications, strengthening, repairs, and operational incidents all constitute part of the SIM knowledge base.

SIM data falls into two broad categories:

- **Characteristic Data.** This is the baseline data that defines the structure at installation and includes general platform data (age, water depth, etc.), design data, fabrication data and installation data.
- **Condition Data.** This defines the changes to the characteristic data that have occurred during the operating life of the platform such as platform modifications, inspections, damage, etc.

The importance of maintaining and updating the SIM data with an efficient management system cannot be over-stated. To facilitate periodic "evaluation" and related updates of the SIM "strategy", such as inspections, it is necessary that the Operator retain detailed records for the life of the platform. During change of ownership the Operator should ensure transfer of all platform data.

**Evaluation**

Evaluation occurs throughout the life of a platform. As additional data is collected, an engineering evaluation should be performed. Data may come from periodic inspections, as a result of incidents or accidental events, on-line monitoring systems, platform modifications/additions, technology developments or general industry learning's.

The evaluation establishes the requirement for structural assessment to demonstrate fitness-for-purpose. Guidance is provided in RP 2SIM for the evaluation of data with specific recommendations for the evaluation of:

- Consequence of Platform Failure
- Risk of Platform Failure
- Requirement for Platform Assessment

***Consequence of Platform Failure***

The consequence of platform failure is used to establish key aspects of the SIM process such as inspection frequency and the criteria for assessment. RP 2A uses a consequence based approach, which is repeated in the RP 2SIM. However, RP 2SIM also allows a risk- based approach for inspection planning, which includes both consequence and the likelihood of platform failure.

RP 2SIM is consistent with other RPs and provides consequence of failure categorization guidance based on the consideration of "life-safety" and "other" consequences of platform failure. The consequence category to be assigned to a platform is the more restrictive level for life-safety or other consequence of failure. The RP 2SIM consequence categories generally follow those of RP2A Section 1 and are summarized as follows:

<u>Life Safety.</u> This considers the maximum anticipated metocean or other design event that would be expected to occur while personnel are on the platform. The categories are defined as:

- High - Manned-nonevacuated
- Medium - Manned-evacuated
- Low - Unmanned

<u>Other Consequences of Failure.</u> This considers environmental damage, business disruption (lost production, repair, replacement, decommissioning), public perception, impact to other operators and market supply disruption. Specific guidance for selection of these is provided in RP 2SIM.

- High Consequence
- Medium Consequence
- Low Consequence

***Risk of Platform Failure***

RP 2SIM introduces the concept of a risk-based inspection strategy, which will allow operators to better focus inspection resources and optimize inspection planning. Risk is the combination of the Consequence of Platform Failure (Life Safety and Other Consequences as defined above) and the Likelihood of Failure. Each platform has a Likelihood of Failure based on key structural characteristics that affect the platform's reserve and residual strength, such as the RP used for design, the structural redundancy and robustness (tolerance to damage) provided by the number of legs and bracing configuration. Changes in platform condition such as damage or degradation may also increase the Likelihood of Failure.

Determining the Platform Risk can be accomplished by using a risk matrix approach, as is common in the industry, although other approaches for determining Risk are acceptable. RP 2SIM does not establish a specific risk matrix requirement. This is up to the Owner, but an example 3x3 risk matrix is provided as shown in Figure 4, with the following risk categories:

- Risk Level 1 – High risk platforms, which require major focus of SIM resources perhaps including increased frequency and intensity of inspection.
- Risk Level 2 – Medium risk platforms.
- Risk Level 3 – Low risk platforms.

| Consequence of Failure | Likelihood of Failure: Low | Likelihood of Failure: Medium | Likelihood of Failure: High |
|---|---|---|---|
| High | Risk Level 2 | Risk Level 1 | Risk Level 1 |
| Medium | Risk Level 3 | Risk Level 2 | Risk Level 1 |
| Low | Risk Level 3 | Risk Level 3 | Risk Level 2 |

**Figure 4 – Example Risk Matrix for Risk Based Inspections**

***Requirement for Platform Assessment***

An assessment is required if evaluation of relevant SIM data determines that one or more of the assessment initiators defined below are triggered. These assessment initiators are the same as in Section 17.

- Addition of Personnel
- Addition of Facilities
- Increased Loading on Structure
- Inadequate Deck Height
- Significant Damage

RP 2SIM will introduce more specific guidance on the assessment of platforms for Change-of-Use conditions. The Change-of-Use concept was introduced in the API Section 17 Supplement [API, 2005], but only general guidance was provided. This occurs when an Owner wishes to “change the use” of a platform from its original purpose to a new purpose. For example, conversion of a conventional wellhead platform to a more critical hub platform to serve as a tie-back for a deepwater development. In such cases, the evaluation processes in SIM may be appropriate, but the use of reduced metocean criteria and some other factors may not be applicable. The specific Change-of-Use approaches to be contained in RP 2SIM are still under development.

**Strategy**

The SIM strategy defines the overall inspection philosophy for the platform or fleet of platforms. It may also define any facility expansion opportunities or mitigation of damage that may occur to the platform.

Guidance is provided to assist in the development of a “default” consequence-based strategy, which is generally consistent with the existing RP 2A and is based on the platform’s Consequence Categorization. Alternatively, to promote engineers to better understand their platforms, guidance on developing a risk-based SIM strategy is provided. The strategy is based on the “risk” of platform failure and will provide owners the opportunity to better focus valuable resources.

The inspection strategy will define the frequency and scope of the inspection and the inspection tools/techniques to be used. The RP 2A Section 14 terminology defines the in-service collection of data offshore as “Surveys”. However, to be more consistent with present industry practice, RP 2SIM uses the terminology “Inspection”.

The strategy for inspection planning is developed to cover the number of future years the platform is expected to operate and will be periodically updated throughout the platform’s life.

The inspection strategy should include the following basic elements:

- <u>Periodic above water inspections.</u> An above water inspection should be carried out on an annual basis. RP 2SIM provides additional information and clarity on the requirements for the above water inspection.
- <u>Baseline underwater inspection.</u> Used to determine the as-installed platform condition, and as a benchmark for the future SIM of the platform. A baseline inspection is required prior to implementation of risk-based inspection.
- <u>Periodic underwater inspections</u>**.** The periodic underwater inspection should be carried out at an interval consistent with the SIM strategy adopted by the Owner/Operator. This may be a prescriptive consequence based strategy with a default frequency and work scope or a more focused risk-based strategy.
- <u>Special inspections.</u> A non-routine inspection initiated by events such as a hurricane or collision.

RP 2SIM allows inspections on a default interval that is based upon consequence of failure, i.e., manned versus unmanned, high versus medium consequence, etc. This is the same approach as is currently contained in RP 2A Section 14. These default intervals are based on historic industry practice that has resulted in satisfactory performance of platforms. The specific inspection intervals may change slightly from RP 2A and this is still under consideration.

Alternatively, a risk-based approach may be used whereby the inspection intervals are adjusted according the platform’s Risk. High Risk platforms require more frequent and perhaps more thorough inspections than Low Risk platforms.

**Program**

The Program represents the execution of the detailed scope of work required to complete the activities defined in the SIM Strategy. To complete the SIM process all data collected during the SIM Program must be fed back into the SIM Data management system.

## Section 4: In-Service Inspection

RP 2SIM is arranged so that the frequency of inspections is determined in Section 3, while Section 4 describes the scopes of work for the inspections. The scope of work depends on the platform susceptibility to defects and anomalies, its robustness and its present condition. The platform’s Consequence Category (or Risk if a risk-based strategy is adopted) is used to establish the inspection scope of work.

The default inspection program is based on the platform’s Consequence Category and is provided if the owner chooses not to establish a long term SIM risk-based plan. The requirements are based on the consequence of platform failure, which only concerns the safeguarding of human life and protecting the environment. Thus, additional inspection may be needed to meet statutory requirements, Operator corporate policy, or industry standards/practices.

If a risk-based inspection strategy is used, the inspection work scopes should be based on the data evaluation process. The risk-based strategy for the development of inspection scopes of work depends upon an understanding of the platform’s susceptibility to damage and the tolerance of the structure to damage. The SIM strategy should match a risk-based inspection interval with a risk-based inspection scope, deployment method (diver versus ROV) and survey techniques employed (general visual versus close visual/NDE).

## Section 5: Damage Evaluation

A number of possible degradation mechanisms may reduce the capacity of the structure. The types of degradation mechanisms include dropped objects, collisions, corrosion, fatigue, overload, etc. Engineering evaluation is a process to determine whether such damage may be significant to the structural integrity of the platform. The significance of the damage depends upon the nature and extent of the damage and the structure's inherent tolerance to damage, i.e., it's robustness.

The objective of the damage evaluation process is to determine if damage is potentially significant to the integrity of the structure and hence if a more detailed engineering assessment is required per the guidance in Section 6.

Significant damage is defined as cumulative damage that decreases the platform's "global" or "system" capacity by 10 percent or more. Significant damage is an 'assessment initiator' as defined in Section 3 and requires an engineering assessment.

RP 2SIM provides specific guidance for the determination of the residual strength of certain types of damage to components of offshore structures as noted below.

- Dented and Bowed Tubular Member
- Uniformly Corroded Tubular Members
- Locally Corroded Tubular Members
- Cracked Tubular Members and Joints
- Cracked Tubular Joint

This detailed guidance was not previously available in RP 2A. The residual strength of the component may be used to assist in the evaluation of the likely reduction of the platform's system capacity and determine if the structure needs a fitness-for-purpose assessment.

## Section 6: Structural Assessment Process

Structural assessment involves the evaluation of the platform using analytical methods that compare the estimated performance of the platform against acceptance criteria. This is typically accomplished by performing a linear or non-linear structural analysis. Alternatively, an assessment may also consist of comparing a proof load of the platform, for example during an extreme storm, against the acceptance criteria. Other more complex assessment methods, such as determining the explicit probability of platform failure are also possible. This section provides guidance for selecting and implementing an assessment approach, including details of various analytical procedures.

When combined, Section 6 and Section 7 of RP 2SIM are similar in content to the original Section 17. However, the analysis and criteria have been divided into two sections. In Section 17 the analysis approaches and the assessment criteria were inter-related within the same section. The intent in RP 2SIM is to provide clearer and more generic assessment processes for structural evaluation and analyses in a stand-alone section, which then refers to a separate section for the specific metocean and acceptance criteria. This allows Section 7 to act as an ISO-style "regional annex" specifically for the U.S. offshore. Future updating of analysis approaches or criteria separately can now be made without the need to change multiple sections. Also, the separate sections will allow RP 2SIM to be used in other regions of the world, with the Section 6 assessment approaches such as Design Level Method and Ultimate Strength Method applicable anywhere, except that the acceptance criteria in Section 7 would be substituted for acceptance criteria specifically for that region of the world. For example, the ISO metocean regional annex for that region.

An assessment is only required if one or more of the Assessment Initiators are "triggered" as defined in Section 3. The criteria that should be used in the assessment are defined in Section 7 and are based upon the Assessment Method and the Assessment Category for the platform. The overall assessment process is shown in Figure 5. There are four key components to the RP 2SIM Assessment process:

1. Assessment Information. This is the data necessary for the assessment. The data should be available from existing platform Characteristic and Condition Data. The data should be up-to-date and reflect the condition of the platform at the time of the assessment. These are generally defined as Above Water Data (topsides structure), Underwater Data, and Soils Data.
2. Assessment Category. The platform will be assessed according to its consequence of failure as defined in Section 3. The Assessment Category is used to determine the specific metocean criteria to be used for the assessment. There are three Assessment Categories known as High, Medium or Low that relate to the consequence of failure definitions contained in Section 3.
3. Assessment Method. This involves determination of the assessment method to be used, followed by the assessment itself. There are four assessment methods. Simple Methods, which provide a method of assessment with minimal effort, for example, comparison to a similar platform. The Design Level Method, which uses linear (elastic) methods to check the platform member-by-member, similar to the approach used for design of new platforms. The Ultimate Strength Method, which uses non-linear (or equivalent linear) methods to determine platform performance on a global basis. Alternative Methods, which use historical performance of the platform or explicit probabilities of survival of the platform.
4. Mitigation. Structures that do not pass the assessment will need mitigation. Mitigation can be modifications or operational procedures that reduce loads, increase capacities, or lower the Assessment Category, such as demanning. Mitigation may be considered at any stage of the assessment process.

Section 17 recommended that the user start with Simple Methods, then move sequentially to the Design Level and then the Ultimate Strength Method. RP 2SIM recommends that the engineer begin with the Method that is the best approach for the SIM situation. For example a damaged structure is best evaluated using a non-linear approach that accounts for load redistribution around damage areas, or accounts for partial member strength. Guidance is provided for the assessment method best suited for the particular SIM issue.

The Assessment Categories are consequence based and relate to the detailed definitions of the life safety or other consequences defined explicitly in Section 3. The assessment categories are:

- High Assessment Category. High life safety and/or high other consequences of failure.
- Medium Assessment Category. Medium life safety and/or medium other consequences of failure.
- Low Assessment Category. Low life safety and/or low other consequences of failure.

The overall evaluation/analysis approaches provided are little changed from Section 17. The A-1, A-2 and A-3 terminology (contained in the Section 17 Supplement) has been shifted to describe specifically the Assessment criteria in Section 7. The wording and tables have been streamlined. And the analysis approaches, including the commentary, have been updated to reflect the considerable improvements in assessment and analysis technologies since Section 17 was originally developed in the early 1990's. Particular enhancements and clarity relate to the non-linear ultimate strength analysis.

Guidance on Fatigue has been expanded, specifically related to secondary conductor guide framing at the first elevation below the waterline, which is a known problem area in the Gulf of Mexico. For the primary vertical and horizontal members, which evidence from in-service inspection data suggests is not fatigue prone [Bucknell, et. al., 2000], guidance on the application of technology during the fatigue analysis is provided.

Structures that do not pass the fitness-for-purpose assessment require a reduction in risk, either through a change in the likelihood of failure and/or change in the platform consequence of failure. Likelihood of failure changes, such as strengthening and/or repairs should be designed to meet the requirements of this section, such that they do not reduce the overall strength of the platform. Mitigation should be considered at all stages of assessment and may be used in lieu of more complex assessment. Detailed guidance on various mitigation techniques are contained in Section 8.

## Section 7: Assessment Criteria and Loads

This section provides the metocean, seismic and ice criteria and load calculation procedures for the assessment of existing platforms for the offshore U.S. In this sense, it is similar to an ISO Regional Annex and is location dependant. The section is intended to be used in parallel with Section 6 on Assessment.

The criteria are provided in accordance with the platform Assessment Category defined in Section 6, and in some cases results in reduced metocean criteria compared to new design. This reduced metocean criteria is intended "exclusively" for use in platform assessment according to RP 2SIM and for the indicated regions of the offshore U.S. It should not be used for the design of new platforms or for platforms located in other regions of the world.

For the Gulf of Mexico, the metocean criteria are determined according to the Assessment Category as follows.

- High Assessment Category (A-1). Full hurricane population. The expectation is that platforms in this category would survive a significant hurricane impact with minimal or no damage.
- Medium Assessment Category (A-2). The primary consequence is the possibility of personnel being caught offshore due to a storm developing so quickly that the platform cannot be successfully evacuated. Therefore the combined sudden hurricane and winter storm population applies. A sudden hurricane is nominally defined as a storm that develops or rapidly intensifies within the Gulf of Mexico thus providing inadequate time for platform evacuation. Winter storm criteria are included because platforms are not evacuated in winter storms.
- Low Assessment Category (A-3). The platform should have enough structural integrity to ensure life safety during operational storm conditions when personnel may be on board.

The metocean criteria are generally the same as Section 17. However, the criteria curves are displayed differently, such that the same criteria (design level, ultimate strength or minimum deck elevation) are provided on the same plot for each of the Assessment Categories. Figure 6 shows an example for the Minimum Deck Elevation criteria and Figure 7 shows an example for the Wave Height Assessment criteria. This format was felt to better display the information, and also helps to emphasize the significant differences in the assessment criteria. This is intended to demonstrate to the platform Owner, that while a platform may pass RP 2SIM criteria, based primarily upon life safety and environmental consequences, it may be designed to a much lower level than other platforms, particularly new platforms, and be at an economic risk. To provide further information on the level of risk incurred as a result of using the consequence-based metocean criteria, additional guidance is provided is provided in the main text and the commentary of RP 2SIM.

RP 2SIM will also allow for the first time in a RP, acceptance based upon minimum RSR values. The SIM JIP Task Group is still evaluating appropriate RSR acceptance values. Present thoughts are shown in Table 1 for platforms designed to the API 19$^{th}$ edition and earlier, with the RSR values essentially those used to develop the Section 17 metocean criteria. For the API 20$^{th}$ and later editions, the values are presently under development and are still to be determined. Platforms located in U.S. areas outside of the Gulf of Mexico will always be a High Assessment Category since Low or Medium consequence structures do not exist in these areas.

| Gulf of Mexico<br>Assessment Category | Reserve Strength Ratio (RSR) | |
|---|---|---|
| | API RP2A 19th Edition and Earlier | API RP2A 20th Edition and Later |
| High | 1.2* | TBD |
| Medium | 0.8 | TBD |
| Low | 0.6** | TBD |

* Not applicable for Change-of Use conditions.
**Not to be used for water depths greater than 400 ft.

| Other U.S. Areas<br>Assessment Category | Reserve Strength Ratio (RSR) | |
|---|---|---|
| | API RP2A 19th Edition and Earlier | API RP2A 20th Edition and Later |
| High | 1.6 | TBD |

**Table 1 - Minimum Acceptable RSRs for U.S. Offshore Fixed Platforms (TBD = To Be Determined)**

## Section 8: Mitigation and/or Risk Reduction

Platforms that have been assessed but do not meet the SIM acceptance criteria are required to reduce the risk of operating the platform. Mitigation involves reducing either the consequence or likelihood of platform failure.

### Consequence Mitigation

If the consequence of failure is controlled by life-safety then mitigation measures should reduce the risk to life-safety sufficiently to lower the Assessment Category, for example, demanning the platform. If the consequence of failure is controlled by environmental impact or some other consequence consideration then other mitigation measures will be required such as removing oil storage.

### Likelihood Mitigation

RP 2SIM will provide guidance and examples for reducing the platform's likelihood of failure either by reducing load or by strengthening the platform.

For example, load reduction may include reducing gravity loads; reducing hydrodynamic loads through the removal of non-essential components such as boat landings, barge bumpers, stairs, etc.; marine growth removal; and/or raising the topsides to avoid wave-in-deck loads in extreme hurricanes.

Alternatively, strengthening may include grouting the leg-pile annulus, grouting members and/or joints, strengthening or adding members with clamps or welding (dry or wet); and external bracing with piles or with a new jacket structure.

## Section 9: Decommissioning

This section is entirely new and with nothing similar contained in RP 2A. The section provides a brief identification of the issues involved in decommissioning an offshore platform. It does not have any specific recommended approaches.

Decommissioning involves closing down operations at the end of field life including shutting in the wells, cleaning up the waste streams, making the platform safe and removing some or all of the facilities and reusing or disposing of them as appropriate. The stages of the decommissioning process are described below and the link to the SIM process is emphasized. Structural decommissioning activities should be integrated with the late-life SIM strategy for the platform to ensure the structural integrity of the platform is consistent with safe access for decommissioning operations.

Topics covered are:

- Pre-Decommissioning Data Gathering. Required in order to gain knowledge of the existing platform and associated facilities, wells, pipelines, risers and subsea equipment.
- Planning and Engineering. Needed to develop the decommissioning plan and to ensure that environmental and life-safety risk is maintained as low as reasonably practical.
- Permitting & Regulations. Needed to ensure compliance with regulators.
- Well Decommissioning. Permanent plugging and abandonment (P&A) off the well bores. It may be advantageous to P&A wells as they become non-productive to reduce the consequences of platform failure.
- Facilities Decommissioning. The flushing, cleaning and removal of process equipment and facilities.
- Pipeline Decommissioning. Should be considered at the time of the platform decommission unless it is handled separately.
- Conductor Removal. This usually occurs prior to the jacket removal. Planning for conductor removal should be integrated with the overall SIM strategy as complete or partial removal of conductors can be an effective mitigation option.
- Structure Decommissioning. The deck and topsides structure are removed and recovered to shore for disposal or reuse. Subject to regulations, the jacket may be toppled in place to form an artificial reef or transported to a designated reef site.
- Site Clearance. After the platform is removed the area must be cleared of debris.

## Impact of Recent Hurricanes

In 2004 and 2005 hurricanes Ivan, Katrina and Rita destroyed over 120 platforms and damaged an equal number. Many of these platforms were fixed based structures installed prior to 1980, which are some of the key focus of the guidelines in RP 2SIM. API, the MMS and industry in general are presently evaluating the impact of these significant hurricanes and the findings may alter some of RP 2SIM or affect its release.

## Summary

RP 2SIM will provide a useful and timely guideline for the continued use of existing fixed based platforms. It is an update and extension of some of the concepts originally contained in RP 2A Section 14 Survey and Section 17 Assessment. It is also influenced by, and consistent with, the draft ISO guidelines for steel offshore structures 19902. The long term plan is for RP 2A to be used for design of new platforms and RP 2SIM to be used for existing platforms. The present schedule is to submit RP 2SIM to API in 2006 for review and comment, including modifications as necessary. Pending API approval, the first API RP 2SIM will likely be published in 2007.

## Acknowledgments

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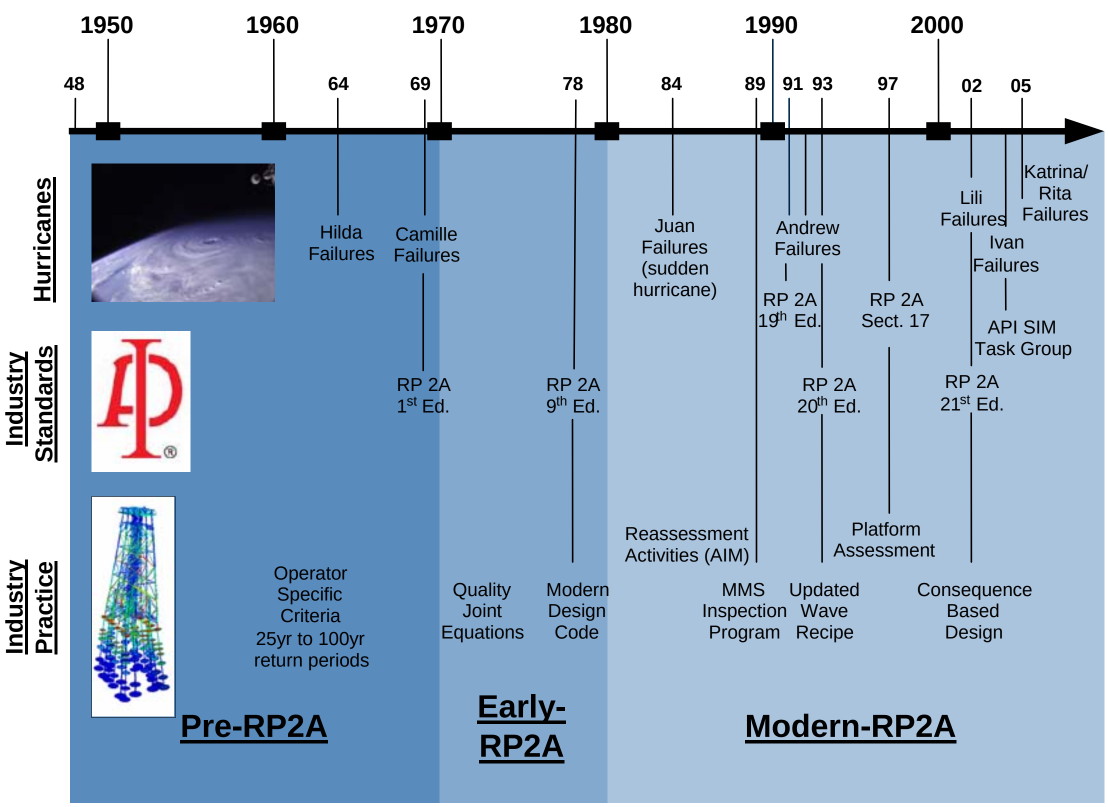


**Figure 1 – The Evolution of Offshore Platform Design in the Gulf of Mexico. Offshore platform design has evolved based upon a combination of events (hurricanes), improvements in industry standards (API) and advances in industry practices.**

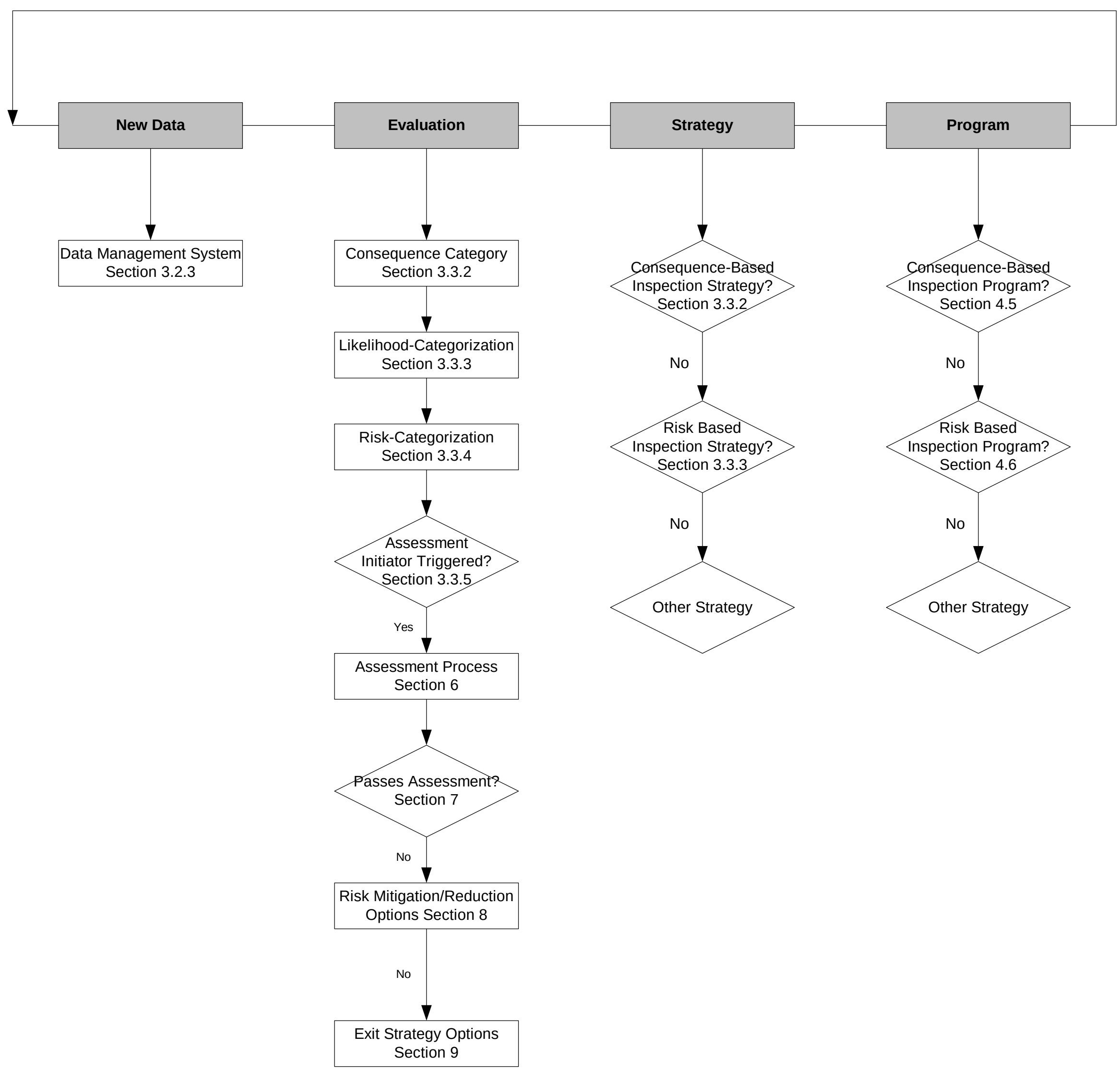


**Figure 3 – Key Flowchart for RP 2SIM Showing Logic and Corresponding Sections of the Document**

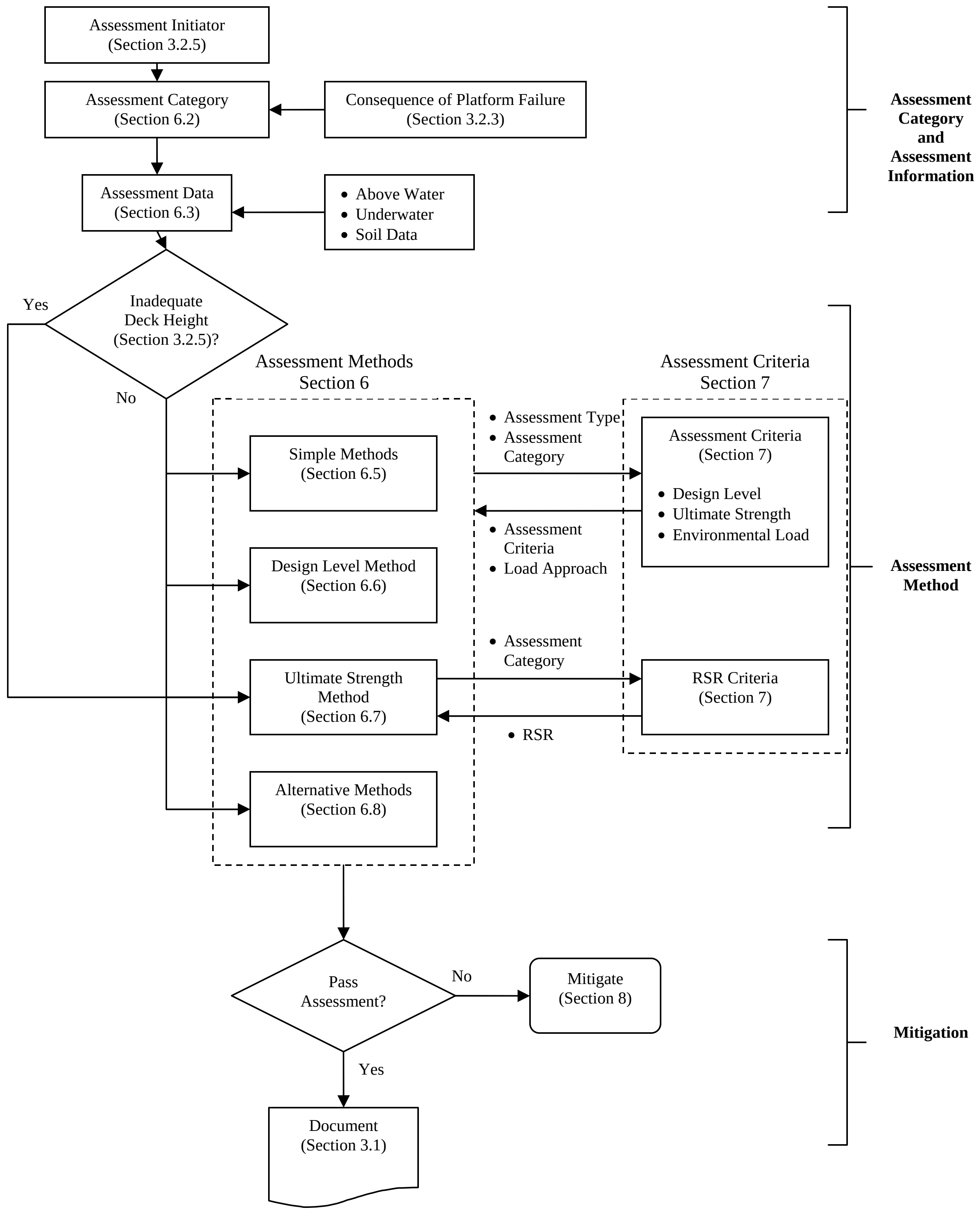


**Figure 5 – Flowchart for Section 6 Structural Assessment Process**

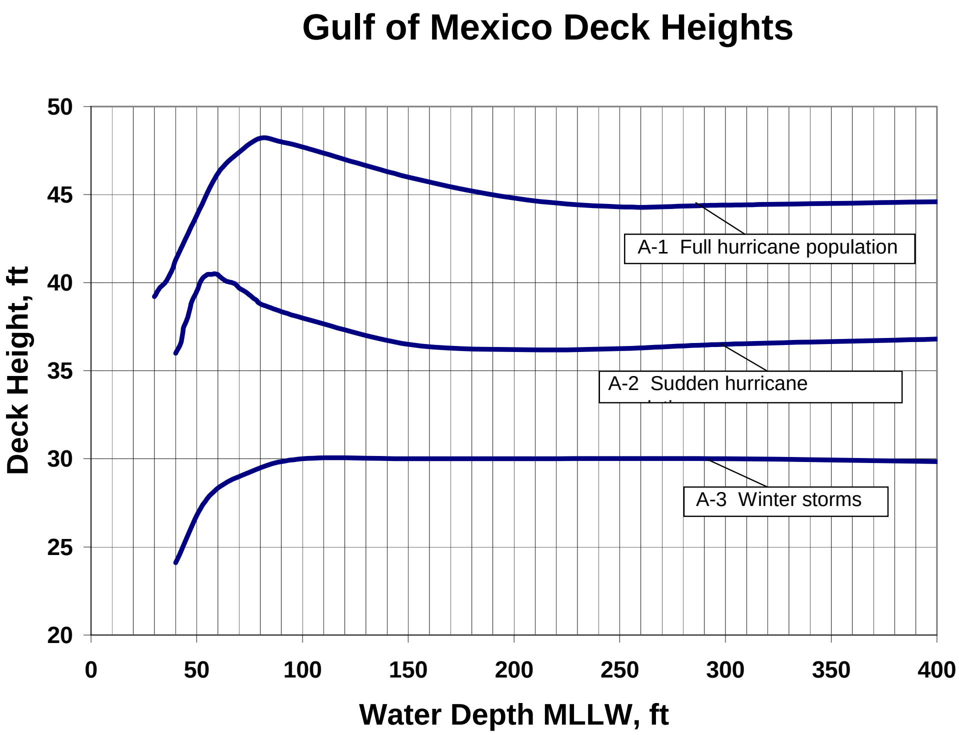


**Figure 6 – Minimum Deck Elevation for the Gulf of Mexico**

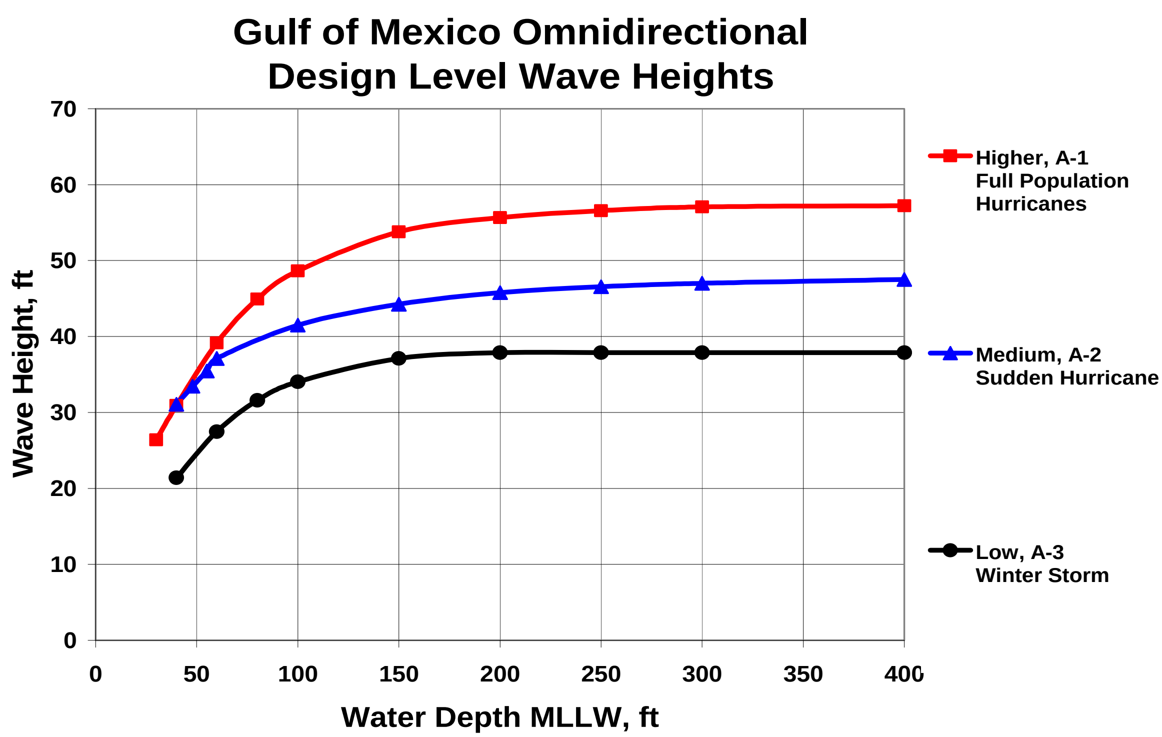


**Figure 7 – Wave Height Assessment Criteria for the Gulf of Mexico**